



Effect of Soil Enhancer (XXL) on the Growth and Developmental Attributes of Brrri Dhan 29 and Hybrid Dhan Taj-1 Cultivars of Rice in *Boro* Season

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Authors' contributions

This work was carried out in collaboration between all authors. Author KUA designed the study. Author MSR performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors MMH and KUA managed the analyses of the study. Author MSR managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was conducted at the Research Field of Sher-e-Bangla Agricultural University, Dhaka-1207 during November, 2015 to July, 2016. XXL (Soil enhancer) is a complex substance which consists of organic humic acid, fulvic acid, 40 different trace elements and other plant hormones. The present study consisted of two varieties (BRRRI dhan 29 and Hybrid dhan Taj-1) and seven different concentrations of soil enhancer (XXL) {Control, 125% (1.88 g/1.5 L), 100% (1.5 g/1.5 L), 75% (1.125 g/1.5 L), 50% (0.75 g/1.5 L), 33% (0.50 g/1.5 L) and 25% (0.38 g/1.5 L)}. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Significant variation was observed in different growth and development contributing characters with XXL. Among the different XXL concentrations, 75% XXL provided the best result. Irrespective of varieties, the highest plant height {92.82 at 80 days after transplanting (DAT)} SPAD value of leaves (32.04 at 80 DAT), tillers hill⁻¹ (15.26 at 80DAT) and leaf area (29.26 cm²) were achieved. With 75% XXL, BRRRI dhan 29 and Hybrid dhan Taj⁻¹ provided their shortest duration of maturation

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of grain (107.3 DAT and 94.33 DAT, respectively). It was 4.1% and 18.41% lower than control, respectively. It meant that BRRi dhan 29 and Hybrid dhan Taj-1 performed well with 75% XXL applied.

Keywords: Rice; soil enhancer (XXL); biofertilizer; SPAD value, panicle insertion and maturity.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food for more than half of the world's population. In Asia more than 90% of this rice is consumed [1]. In Bangladesh rice is the staple food of about 160 million people and it covers 75% of the total cropped area [2]. Bangladesh is the 4th ranking position of rice production in the world [3]. The trend of *Boro* rice production in Bangladesh is increasing day by day but it still very low in compare to others rice growing countries. *Boro* contribute to around 55% to the total rice production in Bangladesh [4]. Bangladesh has been facing persistent challenges in achieving food security due to natural disasters and fluctuations in food prices from the influence of volatile international market for basic food items [5]. Now it is essential to find out sustainable technology for poverty alleviation and ensuring food security for increasing population. So, growth enhancing facilities leads the increasing yield and production performance. PGRs (Plant Growth Regulators) stimulate the growth of plant height, tiller number and yield of rice plant [6]. Humic acid (HA) enhances cell permeability, which in turn made for a more rapid entry of minerals into root cells and so resulted in higher uptake of plant nutrients in rice plant [7]. Organic manure or fertilizer significantly increased the soil pH and the concentrations of nitrogen, available phosphorus, exchangeable potassium, calcium, and magnesium [8]. Foliar application of humic and fulvic acids together led to significant increases of grain, straw rice yield and N, P & K content of grain and straw [7]. XXL (Soil enhancer) is a complex substance which made from million years of highly compressed organic humus in the tropical rainforests. XXL has two main functions- i) soil improvement and ii) fertilizer enhancer. XXL mainly imported from China where they achieved excellent improved yield by using this substance in rice. Plant growth and development are influenced indirectly and directly by humic and fulvic substances which is the main components of XXL. Humic acid (HA) improves soil aggregation, aeration, permeability, water holding capacity, hormonal activity, microbial growth, organic matter mineralization, solubilization, availability of microelements and

some macro elements. Fulvic acid (FA) provides a multitude of benefits like a powerful organic electrolyte, enhances cell division, elongation and root growth. Further, it increases the plant's oxygen uptake capacity with an associated increase in chlorophyll production, as a foliar or soil spray and increase the permeability of plant membranes and uptake of nutrients [9]. Integration of XXL and chemical fertilizers may facilitate the utilization of nutrients for crop growth and productivity and help replenish the organic matter status in soil. Therefore, the present study was designed to investigate the effect of various concentrations of soil enhancer (XXL) on growth and development attributing characters of BRRi dhan 29 and Hybrid dhan Taj-1 in SAU campus. The hybrids and conventional rice varieties differed significantly among themselves with respect to different parameters [10]. The experiment was aimed to evaluate the effect of soil enhancer (XXL) powder on the growth and developmental attributes of rice plant.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted at the Research Field of Sher-e-Bangla Agricultural University, Dhaka-1207 during November, 2015 to July, 2016. The soil of experimental area was silty clay in texture. Soil pH was 6.7 and has organic carbon 0.45%.

2.2 Experimental Treatment

The experiment consisted of seven different concentrations of XXL, which were applied four doses at every seven days interval (one was basal application and rest three after seedling transplanting). Treatments included in the experiment were as follows: - factor a: variety (BRRi dhan 29 and Hybrid dhan Taj-1) and factor b: seven different concentrations of soil enhancer (XXL) {Control, 125% (1.88g/1.5 L), 100% (1.5g/1.5 L), 75% (1.125g/1.5 L), 50% (0.75g/1.5 L), 33% (0.50g/1.5 L) and 25% (0.38g/1.5 L)} with recommended doses of NPKSZn fertilizers. The experiment was laid out in a Randomized

Complete Block Design (RCBD) with three replications. There were 14 plots of 3m² in size in each of 3 replications resulting 42 plots in total.

2.3 Crop Husbandry

The seeds were sown in the seed bed @ 70 gm⁻² in order to have healthy seedlings. Recommended doses of fertilizers such as Urea, TSP, MoP, Gypsum and Zinc sulphate were applied. Two seedlings (21 days) were transplanted in each hill with plant to plant distance 15 cm and row to row distance 20 cm. XXL was a powder prior to spray. XXL was diluted to get working solution. XXL solution was applied in the form of spray in the soil by hand sprayer or knapsack sprayer. The sprays were made at early hours to avoid dehydration effect.

2.4 Data Collection

Ten pre-selected hills per plot from which different data were collected. Data on the following parameters were recorded during the course of the experiment such as: - plant height, number of tillers hill⁻¹, leaf area, SPAD value of leaf, 1%, 50% and 100% booting stage (DAT), 1%, 50% and 100% panicle insertion stage (DAT) and 1st and final days to maturity (DAT).

2.5 Statistical Package

All the collected data were tabulated and analyzed statistically using analysis of variance technique and subsequently Least Significance Difference (LSD at 5%) for comparing the treatment means, by MSTAT-C software [11].

3. RESULTS AND DISCUSSION

3.1 Plant Height

The plant height varied significantly among the test rice varieties at different DAT and at harvest (Fig. 1). At 20, 40, 60, 80 DAT and at harvest, the tallest plant (30.13, 56.62, 66.29, 92.37 and 98.58 cm, respectively) were observed from Hybrid dhan Taj-1, while the shortest plant (24.08, 43.99, 61.33, 79.37 and 94.65 cm, respectively) from BRR1 dhan 29.

The plant height was significantly influenced due to the effect of different concentrations of XXL in the growth period over control (Fig. 2).

Application of XXL as soil enhancer enhanced the plant height. Among the XXL concentrations, 75% XXL produced the tallest plant (29.01, 53.57, 68.72, 92.82 and 104.8 cm) at 20, 40, 60, 80 DAT and at harvest, respectively, whereas the control treatment showed the shortest plant (25.19, 46.30, 60.29, 78.46 and 89.83 cm) at 20, 40, 60, 80 DAT and at harvest, respectively. It was also observed that the increasing XXL levels increased the plant height up to 75% after that it was decreased for its high concentration which may be destructive for the plant growth at the whole data recording period because 75% XXL with normal dose of fertilizers improved the soil condition and provide the best environment to the plant for nutrient uptake, so that plant can achieve the best growth rate and potential.

Interaction effect of different concentrations of XXL and rice varieties showed significant variation on plant height at different DAT and at harvest (Table 1). At 20, 60, 80 DAT and at harvest, the tallest plant (32.47, 71.72, 98.94 and 108.7cm, respectively) were observed from the combination of Hybrid dhan Taj-1 with 75% XXL but Hybrid dhan Taj-1 with 125% XXL showed the highest plant height (61.17cm) at 40 DAT than other combinations, whereas the shortest plant (40.11, 57.27, 74.43 and 87.94 cm, respectively) were recorded from the combination of BRR1 dhan 29 with control treatment at 40, 60, 80 DAT and at harvest but BRR1 dhan 29 with 125% XXL showed the shortest plant height (22.42 cm) at 20 DAT.

Varieties produced different plant height on the basis of their varietal characters and also genetically influences but environmental and different management practices also influence plant height. The earlier significant effects on plant height for different rice variety [12]. Humic and fulvic acid increased the nitrogen which probably favored the cellular activities during panicle formation and development of rice plant that led to increased number of plant height [7]. Plant height was significantly influenced by different doses of humic acid in rice plant and humic acid produced the longest plant (86.33 cm) by the application of 3 L ha⁻¹ [13]. Humic compounds such as humic acid and fulvic acid have been shown to stimulate plant growth in terms of increasing plant height as well as enhancing nutrient uptake in corn plant [14].

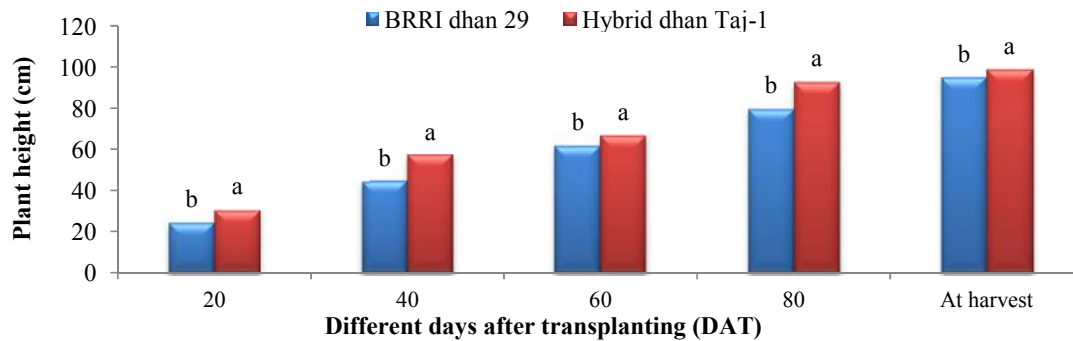


Fig. 1. Plant height of rice at different days after transplanting
 (LSD_(0.05) = 1.34, 2.28, 3.47, 3.64 and 3.89 at 20, 40, 60, 80 DAT and at harvest, respectively)

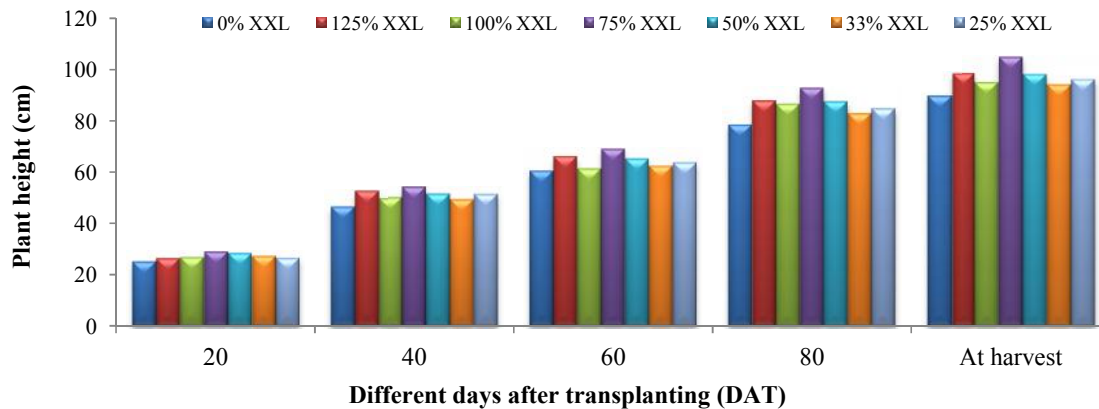


Fig. 2. Effect of different concentrations of XXL on the plant height of rice at different days after transplanting
 (LSD_(0.05) = 2.50, 4.27, 6.48, 6.81 and 7.28 at 20, 40, 60, 80 DAT and at harvest, respectively)

3.2 SPAD Value of Leaf

SPAD meter reading of leaf was analyzed and presented in order to having an idea about relative chlorophyll content per unit leaf area of the rice varieties. Chlorophyll content was significantly affected by the test rice varieties (Fig. 3). The highest SPAD value (36.36, 37.87, 32.18 and 31.12) at 40, 60, 80 and 100 DAT, consecutively were obtained from BRRI dhan 29, whereas the lowest SPAD value (34.11, 33.16, 26.62 and 25.35) at 40, 60, 80 and 100 DAT, consecutively were obtained from Hybrid dhan Taj-1.

SPAD value of leaf was varied significantly with different concentrations of XXL at 40, 60, 80 DAT except 100 DAT (Fig. 4). At 40 and 80 DAT the maximum SPAD value (38.92 and 32.04, respectively) were found from 75% XXL and (37.19% and 29.16%) were found from 50% and

125% XXL at 60 and 100 DAT, which were statistically similar to 75% XXL (37.05% and 27.99%, respectively), while the minimum SPAD value (33.24, 33.31 and 26.86) at 40, 60 and 100 DAT, respectively were found from control treatment and at 80 DAT (27.64) was found from 33% XXL.

Interaction effect of different concentrations of XXL and rice varieties showed significant variation on SPAD value of leaf at different DAT (Table 2). The combination of BRRI dhan 29 with 75% XXL showed the maximum SPAD value (39.78, 34.17 and 32.74) at 40, 80 and 100 DAT, respectively and (40.91) at 60 DAT with 125% XXL, which was statistically similar to BRRI dhan 29 with 75% XXL (39.03). The minimum SPAD value (32.86, 31.57, 23.87 and 23.43) at 40, 60, 80 and 100 DAT, respectively were obtained from the combination of Hybrid dhan Taj-1 with control treatment.

Humic acid (HA) foliar spray might have improved the chlorophyll content, increased the CO₂ assimilation in rice plants and increased the uptake of nutrients by plants [9]. Humic acid increased yield of crops through exerting its positive physiological influences by increasing leaf chlorophyll concentration [15]. Humic acid was able to increase SPAD values under salt stress treatment in the common bean leaves. Humic acid can facilitate respiration and photosynthesis processes via modified functioning of mitochondria and chloroplasts [16]. Humic acid application significantly influenced total chlorophyll content and this effect was mainly on chlorophyll b content. Foliar 20 ml/l

and soil 20 ml/l humic acid application resulted in the highest total chlorophyll content in pepper plant [17].

3.3 Number of Tillers hill⁻¹

Significant variation was recorded in terms of number of total tillers hill⁻¹ for rice varieties at 40, 60 and 80 DAT except 20 DAT (Fig. 5). At 20, 40, 60 and 80 DAT the maximum number of total tillers hill⁻¹ (10.73, 15.33, 13.88 and 11.99, respectively) were recorded from BRRi dhan 29, while the minimum number (10.63, 11.74, 10.9 and 8.92, respectively) were obtained from Hybrid dhan Taj-1.

Table 1. Interaction effect of variety and XXL on the plant height of rice at different days after transplanting and at harvest

Treatments	Plant height at different days after transplanting (DAT)				
	20	40	60	80	At harvest
BRRi dhan 29 ×					
0% XXL	22.54 f	40.11 e	57.27 c	74.43 e	87.94 d
125% XXL	22.42 f	43.63 de	61.69 bc	78.27 de	95.03 b-d
100% XXL	23.39 f	44.63 de	60.83 c	80.59 de	94.60 b-d
75% XXL	25.55 d-f	46.77 cd	65.72 a-c	86.70 b-d	100.8 a-c
50% XXL	25.53 d-f	44.73 de	63.54 a-c	81.57 c-e	97.42 b-d
33% XXL	24.59 ef	42.30 de	58.60 c	74.87 e	92.10 b-d
25% XXL	24.54 ef	45.77 de	61.68 bc	79.17 de	94.62 b-d
Hybrid dhan Taj-1 ×					
0% XXL	27.84 c-e	52.50 bc	63.32 a-c	82.50 c-e	91.72 cd
125% XXL	30.37 a-c	61.17 a	70.10 ab	97.51 a	102.1 ab
100% XXL	30.22 a-c	54.20 b	61.40 bc	92.56 ab	95.22 b-d
75% XXL	32.47 a	60.37 a	71.72 a	98.94 a	108.7 a
50% XXL	31.43 ab	56.93 ab	66.43 a-c	93.62 ab	98.75 a-c
33% XXL	29.90 a-c	55.37 ab	65.75 a-c	91.00 a-c	96.01 b-d
25% XXL	28.69 b-d	55.80 ab	65.35 a-c	90.46 a-c	97.54 b-d
LSD (0.05)	3.54	6.04	9.17	9.63	10.3
CV (%)	7.78	7.15	8.56	6.68	6.35

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

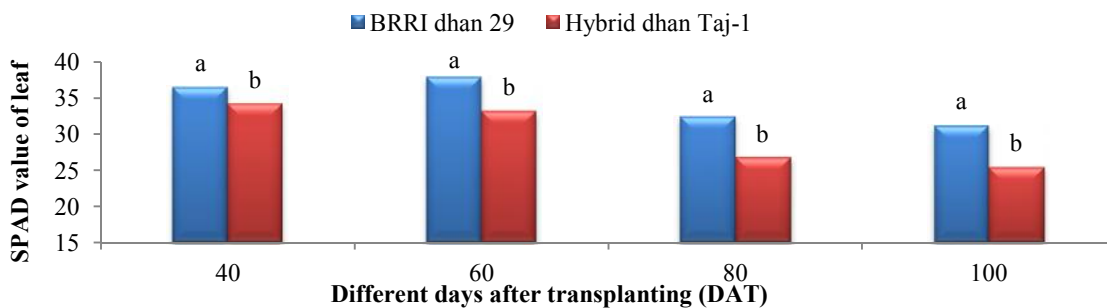


Fig. 3. Effect of variety on the SPAD value of rice leaf at different days after transplanting (LSD (0.05) = 1.60, 1.68, 1.46 and 1.39 at 40, 60, 80 and 100 DAT, respectively)

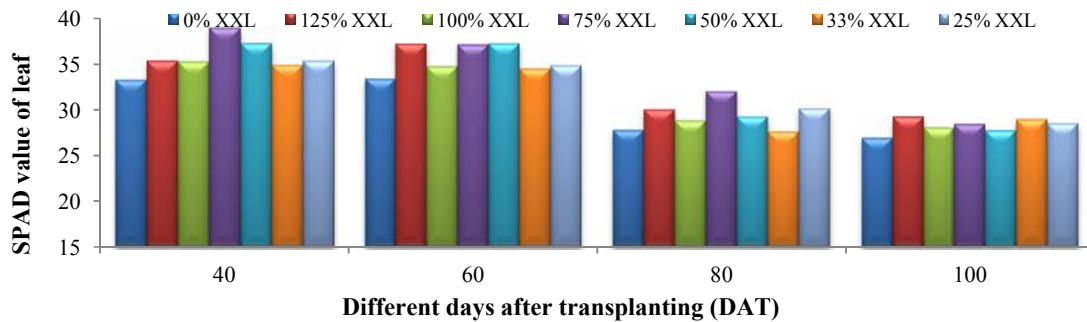


Fig. 4. Effect of different concentrations of XXL on the SPAD value of rice leaf at different days after transplanting
(LSD_(0.05) = 3.03, 3.20, 2.73 and NS at 40, 60, 80 and 100 DAT, respectively)

Table 2. Interaction effect of variety and XXL on the SPAD value of rice leaf at different days after transplanting

Treatments	SPAD value of leaf at different days after transplanting (DAT)			
	40	60	80	100
BRR1 dhan 29 ×				
0% XXL	33.61 c	35.05 b-d	31.73 a-d	30.29 ab
125% XXL	36.14 ac	40.91 a	32.01 a-c	32.11 a
100% XXL	35.75 a-c	36.67 a-c	32.96 ab	31.89 ab
75% XXL	39.78 a	39.03 ab	34.17 a	32.74 a
50% XXL	37.92 ab	39.68 a	31.80 a-d	30.66 ab
33% XXL	35.36 bc	36.86 a-c	30.43 a-e	29.59 a-c
25% XXL	35.97 a-c	36.90 a-c	32.16 ab	30.58 ab
Hybrid dhan Taj-1 ×				
0% XXL	32.86 c	31.57 d	23.87 g	23.43 e
125% XXL	34.55 bc	33.42 cd	28.12 d-f	26.22 c-e
100% XXL	34.70 bc	32.68 cd	24.69 fg	24.09 e
75% XXL	38.07 ab	35.06 b-d	29.91 b-e	24.13 e
50% XXL	36.55 a-c	34.71 b-d	26.75 e-g	24.84 de
33% XXL	34.36 bc	32.00 d	24.86 fg	28.34 b-d
25% XXL	34.69 bc	32.68 cd	28.17 c-f	26.42 c-e
LSD_(0.05)	4.29	4.52	3.86	3.67
CV (%)	7.05	7.47	7.83	7.74

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

The application of different concentrations of XXL showed statistically significant variations for number of total tillers hill⁻¹ at different DAT (Fig. 6). At 20, 40, 60 and 80 DAT the maximum number of total tillers hill⁻¹ (12.93, 12.93, 15.98 and 15.26, respectively) were found from 75% XXL, while the minimum number (8.88, 8.88, 11.25 and 10.05, respectively) were from control treatment.

The number of total tillers hill⁻¹ showed significant variation due to the interaction effect of different concentrations of XXL and rice varieties at 20, 40, 60 and 80 DAT (Table 3). At 20, 40, 60 and 80 DAT the maximum number of total tillers hill⁻¹

(13.30, 13.30, 18.20 and 17.42, respectively) were recorded from the combination of BRR1 dhan 29 with 75% XXL, whereas the minimum number of tillers hill⁻¹ (8.7, 8.7, 10.03 and 9.27) were recorded at 20, 40, 60 and 80 DAT, respectively from the combination of Hybrid dhan Taj-1 with control treatment.

Humic and fluvic acid increased the nitrogen which probably favored the cellular activities that led to increased number of tillers hill⁻¹ of rice plant [7]. Applying 50% of the chemical fertilizers at low levels of organic matter application could compensate for nutrient deficiency and improve plant growth including number of tillers per plant

[18]. The application of compost together with NPK fertilizers significantly increased number of tillers per rice plant [19].

3.4 1%, 50% and 100% Booting Stage

The variety had significant influence on 1%, 50% and 100% booting stage of rice (Fig. 7). The minimum days required for 1%, 50% and 100% booting stage (52.81, 55.00 and 58.09 days, respectively) were found from Hybrid dhan Taj-1 and the maximum days (67.71, 70.19 and 73.95

days, respectively) were found from BRRRI dhan 29.

Significant variation was observed from 50% and 100% booting stage of rice due to different concentrations of XXL except 1% booting stage (Fig. 8). The minimum days required for 1%, 50% and 100% booting stage (59.17, 61.33 and 64.50 days, respectively) were found from 75% XXL, whereas the maximum days (60.50, 63.33 and 67.50 days, respectively) recorded from the control treatment.

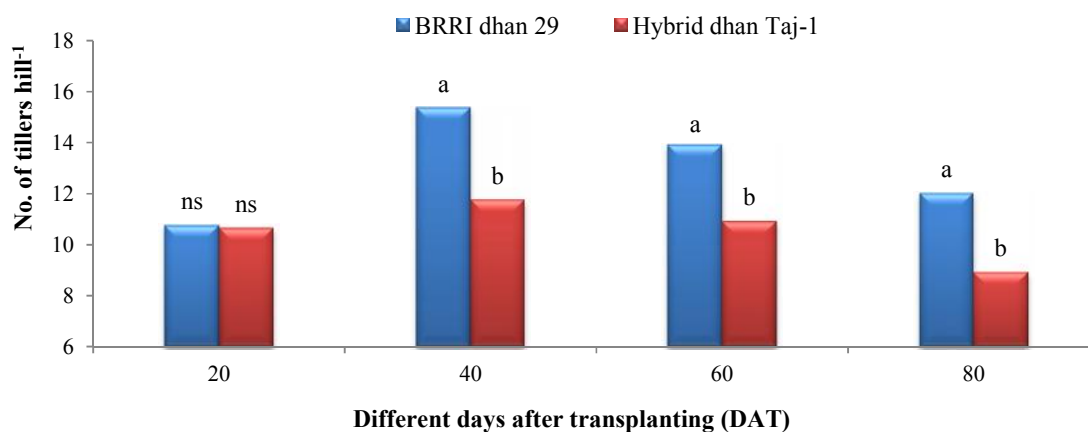


Fig. 5. Effect of variety on the number of tillers hill⁻¹ of rice at different days after transplanting (LSD (0.05) = NS, 0.63, 0.59 and 0.59 at 20, 40, 60 and 80 DAT, respectively)

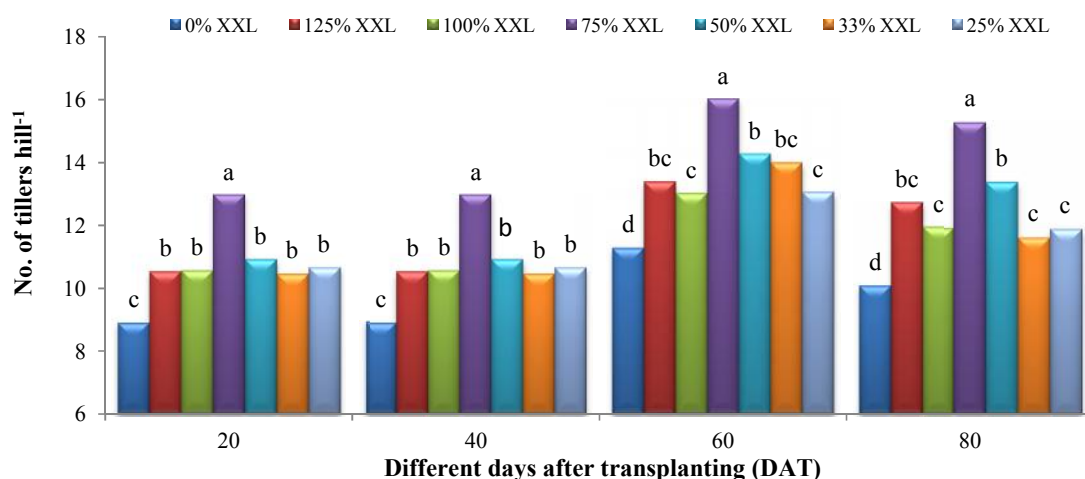


Fig. 6. Effect of different concentrations of XXL on the number of tillers hill⁻¹ of rice at different days after transplanting (LSD (0.05) = 1.03, 1.17, 1.11 and 1.11 at 20, 40, 60 and 80 DAT, respectively)

Table 3. Interaction effect of variety and XXL on the number of tillers hill⁻¹ at different days after transplanting of rice

Treatments	No. of tillers at different days after transplanting (DAT)			
	20	40	60	80
BRRi dhan 29 ×				
0% XXL	9.07 ef	9.07 ef	12.47 ef	10.83 de
125% XXL	9.53 d-f	9.53 d-f	14.17 cd	13.23 c
100% XXL	10.33 c-e	10.33 c-f	15.60 bc	13.53 c
75% XXL	13.30 a	13.30 a	18.20 a	17.42 a
50% XXL	11.37 bc	11.37 bc	16.30 b	15.37 b
33% XXL	10.70 cd	10.70 c-e	15.57 bc	13.10 c
25% XXL	10.83 cd	10.83 cd	15.03 b-d	13.67 c
Hybrid dhan Taj-1 ×				
0% XXL	8.700 f	8.70 f	10.03 g	9.267 f
125% XXL	11.47 bc	11.47 bc	12.53 ef	12.13 cd
100% XXL	10.73 cd	10.73 cd	10.37 g	10.27 ef
75% XXL	12.57 ab	12.57 ab	13.77 de	13.10 c
50% XXL	10.40 c-e	10.40 c-e	12.17 f	11.37 de
33% XXL	10.13 c-f	10.13 c-f	12.33 ef	10.10 ef
25% XXL	10.43 c-e	10.43 c-e	11.00 fg	10.07 ef
LSD_(0.05)	1.46	1.66	1.57	1.56
CV (%)	8.12	7.31	7.53	8.91

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

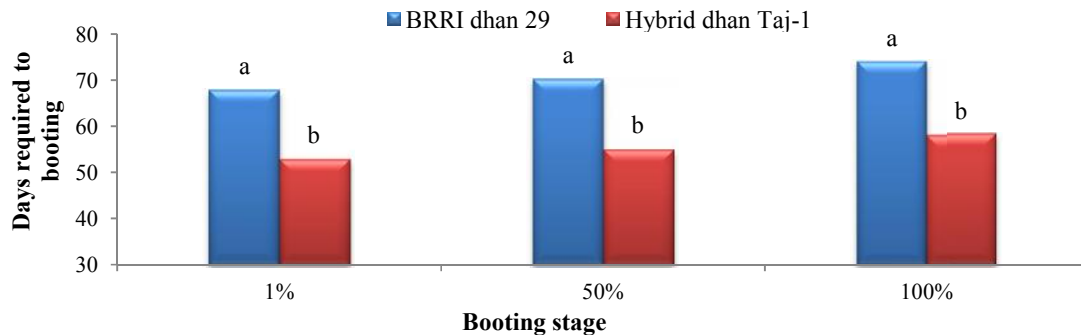


Fig. 7. Effect of variety on the days required to booting of rice
(LSD_(0.05) = 1.24, 0.96 and 1.59 at 1%, 50% and 100% booting, respectively)

1%, 50% and 100% booting stage of rice were significantly influenced by the interaction effect of different concentrations of XXL and rice varieties (Table 4). The minimum days required for 1%, 50% and 100% booting stage (52.33, 52.33 and 56.67 days, respectively) were recorded from the combination of Hybrid dhan Taj-1 with 75% XXL, whereas the maximum days (71.33 and 76.00 days) recorded from the combination of BRRi dhan 29 with control treatment at 50% and 100% booting stage, respectively and (67.67 days) with 125% XXL at 1% booting stage.

The addition of 100 to 300 ppm of fulvic acid (FA) produced highly significant increases in the

growth and development of above and below ground cucumber plant parts and in the formation of numbers of flowers per plant [20]. Physiological and molecular data suggests brassinosteroids as a putative additional factor through which humic substances (HS) could exert their effects on plant development [21].

3.5 1%, 50% and 100% Panicle Insertion

1%, 50% and 100% panicle insertion stage were significantly influenced by the rice varieties (Fig. 9). The lowest days required for 1%, 50% and 100% panicle insertion stage (59.62, 66.86 and 77.95 days, respectively) were recorded from the

Hybrid dhan Taj-1, whereas the highest days (75.05, 82.71 and 87.24 days, respectively) were recorded from the BRRi dhan 29.

1%, 50% and 100% panicle insertion stage were significantly influenced by the different concentrations of XXL (Fig. 10). The lowest days required for 1%, 50% and 100% panicle insertion stage (65.17, 72.83 and 77.33 days, respectively) were recorded from 75% XXL, whereas the highest days (70.00, 78.67 and 87.50 days, respectively) were recorded from the control treatment.

Interaction effect of different concentrations of XXL and rice varieties showed significant influenced on the 1%, 50% and 100% panicle insertion stage (Table 4). The minimum days required for 1%, 50% and 100% panicle insertion stage (57.67, 65.00 and 72.67 days, respectively) were recorded from the combination of Hybrid dhan Taj-1 with 75% XXL,

whereas the maximum days (78.00, 85.67 and 92.00 days, respectively) recorded from the combination of BRRi dhan 29 with control treatment.

IAA (3-indole acetic acid) treatment increased spikelet growth and development in the distal branches of rice plant [22]. The addition of 100 to 300 ppm of fulvic acid produced highly significant increases in the growth and development of above and below ground cucumber plant parts and in the formation of numbers of flowers per plant [20].

3.6 Leaf Area

Leaf area varied significantly for the different rice varieties (Fig. 11). The biggest leaf area (27.55 cm²) was observed from Hybrid dhan Taj-1, while the smallest leaf area (22.58 cm²) was observed from BRRi dhan 29.

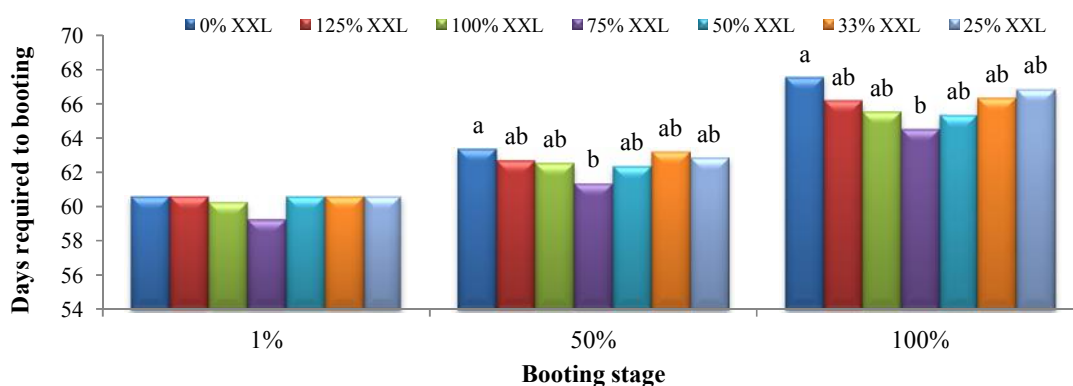


Fig. 8. Effect of different concentrations of XXL on the days required to booting of rice (LSD_(0.05) = NS, 1.80 and 2.97 at 1%, 50% and 100% booting, respectively)

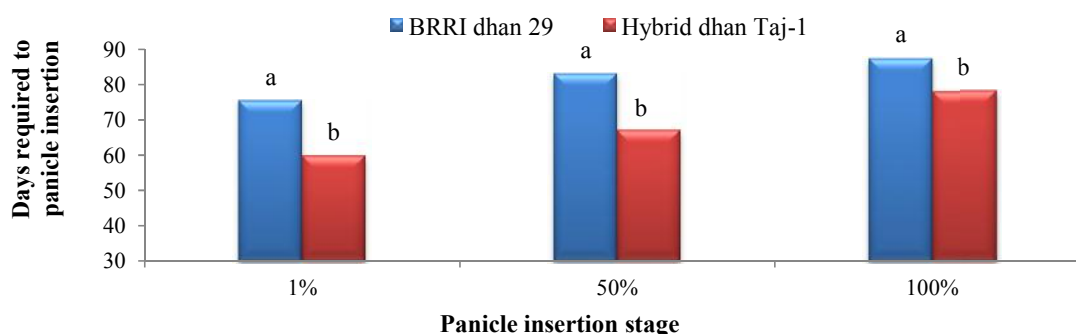


Fig. 9. Effect of variety on the days required to panicle insertion of rice (LSD_(0.05) = 2.02, 2.26 and 2.29 at 1%, 50% and 100% panicle insertion, respectively)

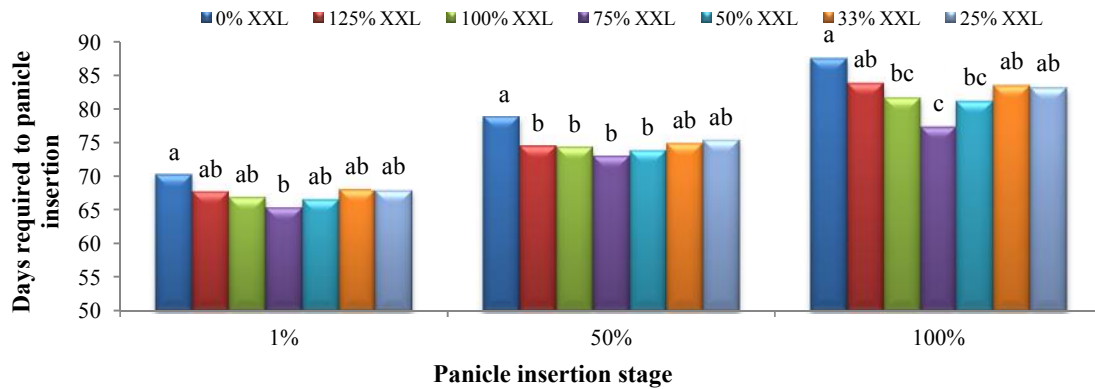


Fig. 10. Effect of different concentrations of XXL on the days required to panicle insertion of rice

(LSD $(_{0.05})$ = 3.78, 4.22 and 4.35 at 1%, 50% and 100% panicle insertion, respectively)

Table 4. Interaction effect of variety and XXL on the days required to booting and panicle insertion stages of rice

Treatments	Booting stages (DAT)			Panicle insertion stages (DAT)		
	1% Booting	50% Booting	100% Booting	1% Panicle insertion	50% Panicle insertion	100% Panicle insertion
BRRI dhan 29 ×						
0% XXL	67.33 a	71.33 a	76.00 a	78.00 a	85.67 a	92.00 a
125% XXL	68.67 a	70.67 a	74.67 a	76.00 a	83.67 a	89.67 ab
100% XXL	67.33 a	70.00 a	73.33 a	74.33 a	81.33 a	87.33 a-d
75% XXL	66.00 a	69.33 a	72.33 a	72.67 a	80.67 a	82.00 d-f
50% XXL	68.67 a	69.33 a	72.33 a	73.00 a	81.33 a	85.67 b-d
33% XXL	68.67 a	70.67 a	74.33 a	75.67 a	82.33 a	85.67 b-d
25% XXL	67.33 a	70.00 a	74.67 a	75.67 a	84.00 a	88.33 a-c
Hybrid dhan Taj-1 ×						
0% XXL	53.67 b	55.33 b	59.00 b	62.00 b	71.67 b	83.00 c-e
125% XXL	52.33 b	54.67 b	57.67 b	59.00 b	65.00 c	78.00 e-g
100% XXL	53.00 b	55.00 b	57.67 b	59.00 b	67.00 bc	76.00 fg
75% XXL	52.33 b	53.33 b	56.67 b	57.67 b	65.00 c	72.67 g
50% XXL	52.33 b	55.33 b	58.33 b	59.67 b	66.00 bc	76.67 fg
33% XXL	52.33 b	55.67 b	58.33 b	60.00 b	67.00 bc	81.33 d-f
25% XXL	53.67 b	55.67 b	59.00 b	60.00 b	66.33 bc	78.00 e-g
LSD $(_{0.05})$	3.28	2.55	4.20	5.35	5.97	6.16
CV (%)	3.24	2.42	3.79	4.73	4.75	4.38

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Statistically significant variation was recorded for leaf area due to the different concentrations of XXL (Fig. 12). The highest leaf area (29.26 cm²) was recorded from 75% XXL, which was statistically similar to 50% XXL (27.37 cm²), while the lowest (19.32 cm²) was recorded from control treatment.⁻¹.

Interaction effect of different concentrations of XXL and rice varieties showed significant variation on leaf area (Table 5). The highest leaf area (31.51cm²) was observed from the combination of Hybrid dhan Taj-1 with 75% XXL, whereas the lowest (17.98 cm²) was recorded from the combination of BBRI dhan 29 with control treatment.

Humic acid was able to increase leaf area in the common bean leaves. General strong increases in leaf area (cm^2) were observed in almost plants treated with humic acid and facilitate respiration and photosynthesis processes via modified functioning of mitochondria and chloroplasts [16]. The increases of parameters in response to application of nitrogenous fertilizers is probably due to enhancing availability of nitrogen which enhanced leaf area resulting in higher photo assimilates and thereby resulted in more dry matter accumulation in rice plant [7].

3.7 1st and Final Days to Maturity

The variety had significant influence on the 1st and final days to maturity (Fig. 13). The minimum days for 1st and final days to maturity (81.09 and 96.57 days, respectively) were recorded from the Hybrid dhan Taj-1, while the maximum days to maturity (95.09 and 109.57 days, respectively) from the BRRRI dhan 29.

Statistically significant variation was observed from final days to maturity due to different

concentrations of XXL except 1st days to maturity (Fig. 14). The minimum days for 1st and final days to maturity (86.33 and 100.8 days, respectively) were recorded from 75% XXL, whereas the maximum days to maturity (90.17 and 105.3 days, respectively) were recorded from control treatment.

Interaction effect of different concentrations of XXL and rice varieties showed significant variation on 1st and final days to maturity (Table 5). The minimum days for 1st and final days to maturity (80.00 and 94.33 days, respectively) were obtained from the combination of Hybrid dhan Taj-1 with 75% XXL, whereas the maximum days to maturity (98.00 and 111.7 days, respectively) from the combination of BRRRI dhan 29 with control treatment.

HA (humic acid) treatments increased the early yield of tomato compared to control. The yield of tomato was significantly influenced by soil and foliar HA applications [23]. Foliar and soil HA applications also led to significantly higher mean fruit weight and early yield of pepper than that of control [17].

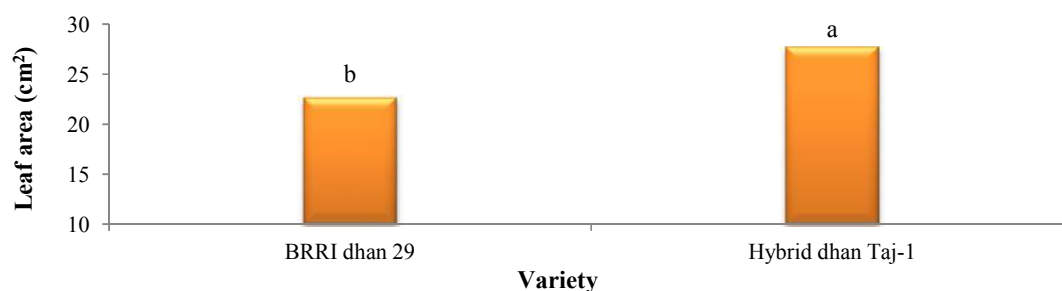


Fig. 11. Effect of variety on the leaf area of rice
($LSD_{(0.05)} = 1.20$)

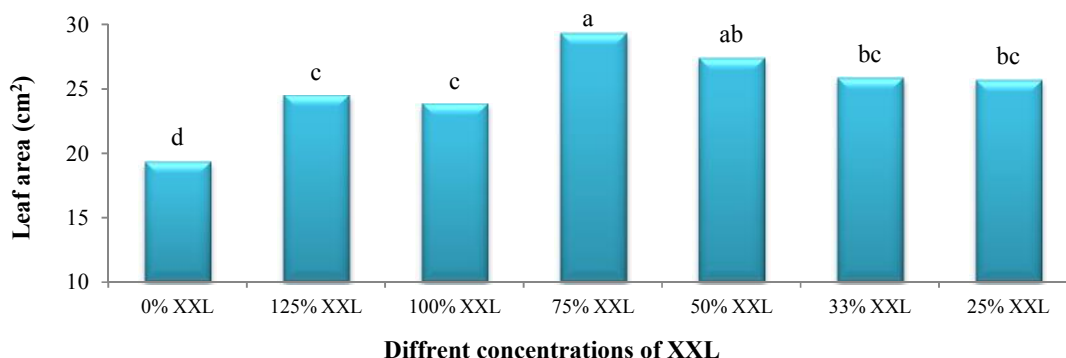


Fig. 12. Effect of different concentrations of XXL on leaf area of rice
($LSD_{(0.05)} = 2.25$)

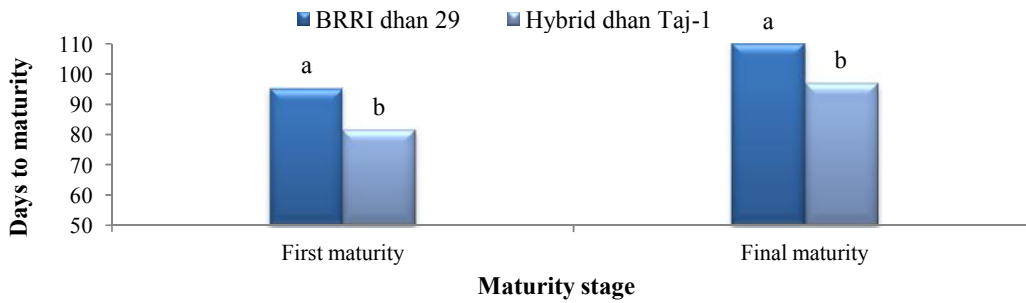


Fig. 13. Effect of variety on the days to maturity of rice
(LSD_(0.05) = 2.07 and 2.12 at 1st and final maturity, respectively)

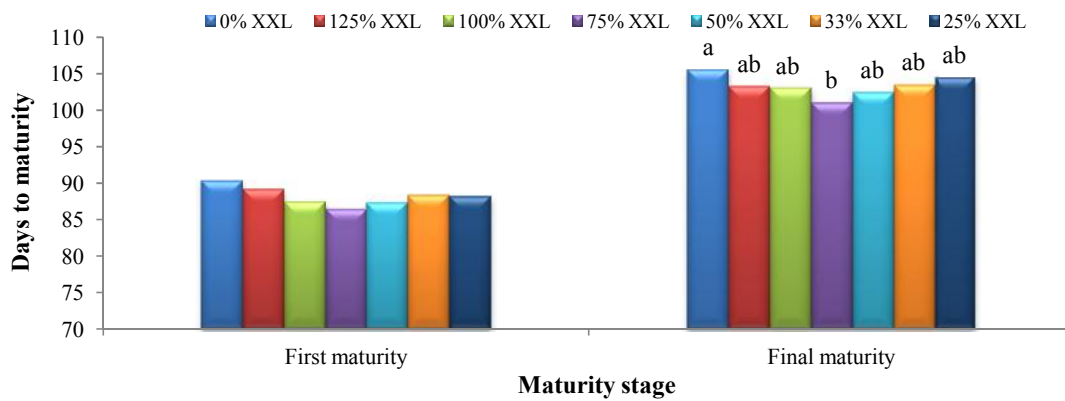


Fig. 14. Effect of different concentrations of XXL on the days to maturity of rice
(LSD_(0.05) = NS and 3.97 at 1st and final maturity, respectively)

Table 5. Interaction effect of variety and XXL on the leaf area and days required to maturity stages of rice

Treatments	Leaf area (cm ²)	Maturity stages (DAT)	
		First maturity	Final maturity
BRRI dhan 29 ×			
0% XXL	17.98 i	98.00 a	111.7 a
125% XXL	19.72 hi	96.67 a	110.3 a
100% XXL	22.52 f-h	94.33 a	109.3 a
75% XXL	27.01 c-e	92.67 a	107.3 a
50% XXL	24.17 ef	93.33 a	108.3 a
33% XXL	23.19 fg	94.67 a	109.3 a
25% XXL	23.49 fg	96.00 a	110.7 a
Hybrid dhan Taj-1 ×			
0% XXL	20.66 g-i	82.33 b	99.00 b
125% XXL	29.04 a-c	81.33 b	95.67 b
100% XXL	24.90 d-f	80.33 b	96.33 b
75% XXL	31.51 a	80.00 b	94.33 b
50% XXL	30.57 ab	81.33 b	96.00 b
33% XXL	28.37 a-c	82.00 b	97.00 b
25% XXL	27.82 b-d	80.33 b	97.67 b
LSD_(0.05)	3.18	5.47	5.62
CV (%)	7.57	3.70	3.25

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

4. CONCLUDING REMARKS

Irrespective of varieties and doses, plant height, SPAD value of leaf, tillers hill⁻¹ and leaf area were increased (8.81%), (6%), (27.16%) and (34.73%), respectively with the application of XXL than that of control. Among the both varieties Hybrid dhan Taj-1 performed the best than that of BRR1 dhan 29 on most of the growth and developmental attributes. Finally, 75% XXL with BRR1 dhan 29 and Hybrid dhan Taj-1 exhibited the superior combinations than that of control on most the parameters studied. However, further study may be needed regarding the effect of XXL on growth and development of test rice varieties in different Agro-Ecological Zones (AEZ) of Bangladesh to recommend a package of technology for use at farmers' level.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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